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ABSTRACT

The purpose of this welding program is to provide students with skills and techniques to become employed as advanced apprentice welders. The welding program manual includes the following sections: (1) course description; (2) general objectives; (3) competencies; (4) curriculum outline for 13 areas; (5) 13 references; and (6) student progress records forms. The 13 areas are: (1) welding metallurgy; (2) manual metal arc process; (3) gas metal arc process; (4) gas tungsten arc process; (5) oxy-fuel welding and brazing; (6) inspection and testing of weldments; (7) basic electricity; (8) blueprint reading; (9) oxy-acetylene cutting; (10) plasma cutter; (11) shop equipment; (12) fabrication; and (13) mathematics for welders. (NLA)

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WELDING

CURRICULUM

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PREPARED FOR:

CONNECTICUT STATE DEPARTMENT OF EDUCATION
DIVISION OF VOCATIONAL, TECHNICAL AND ADULT EDUCATION
VOCATIONAL-TECHNICAL SCHOOL SYSTEM
MIDDLETOWN, CONNECTICUT

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COURSE DESCRIPTION

This course will enable students to develop in-depth skills and techniques in this trade, so that the student will be able to pass welding tests and become employable as an advanced apprentice welder. The students will develop an awareness of good working habits including full knowledge of equipment to be used with all safety rules applied. The students will use tools, machines and materials in both the classroom and on production jobs.

GENERAL OBJECTIVES

One-Year Post Graduate

1. Student will be able to set up, weld and burn with oxy-acetylene equipment safely and correctly.

2. Student will be able to use the manual metal arc process for joining metals in all positions on various joint types.

3. Student will be able to correctly set up and weld steel, aluminum, and stainless steel using the gas Tungsten Arc Welding process.

4. Student will be able to set up and w using the Gas Metal Arc process using both bare wire and fl cored wire.

5. Student will be able to read blueprints and symbols.

6. Student will be able to plan jobs and estimate their costs.

7. Student will be able to safely and correctly set up all the welding, cutting, metalworking, equipment in the shop.

8. Student will be able to make visual and mechanical assessments of welded parts.

9. Student will have sufficient skills for job entry in at least one major area of welding.

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COMPETENCIES

I. The student will be able to identify:

A. Shop Equipment

B. Cylinder Storage Area

C. Emergency Power and Gas Shutoffs

D. Shop Safety Practices

E. Welding Safety Equipment

F. Welding Clothing

II. The student will be able to safely set up:

A. Oxy-Acetylene Welding and Cutting Equipment

B. Students will be able to safely use all welding, cutting, and metal working equipment in the shop.

III. Students will be able to use the SMAW process for joining metals in all positions, using the appropriate electrodes.

IV. Students will be able to set up and weld steel, aluminum, and stainless steel using the gas, tungsten inert gas (GTAW) process.

V. Students will be able to set up and weld using Mig Process, use flux cored and bare wire in all diameters.

VI. The student will be able to read shop welding blueprints along with the welding symbols.

VII. The student will be able to make visual and mechanical assessments of all welded parts.

VIII. The student will be able to demonstrate: Metal Cutting - Oxy-Acetylene-Plasma, Arc Air

A. Safety
   1. Personal
   2. Equipment
   3. Area

B. Fundamentals
   1. Tip selection
   2. Pressures
   3. Tip distance from work
   4. Travel speed
   5. Piercing

C. Equipment
   1. Manual
      a. Types
   2. Attachments
      a. Circle cutter
      b. Gouging
      c. Pipe beveling
      d. Automatic track cutter
      e. Pattern cutting
      f. Stack cutting

IX. Students will be able to pass AWS Guided Bend Test using:

A. Type A-36 steel plate

B. 1/8" dia. 7018 electrodes

C. All position

X. Students will have sufficient skills for job entry in at least one major area of welding in industry.

XI. Students will have mathematic skills to work with:

A. Decimals

B. Fractions

C. Diameters

D. Circumferences

E. Radii

F. Shop math

XII. Students will know how to use:

A. Levels

B. Squares

C. Protractors

D. Rulers

E. Compass

F. Dividers

XIII. Students will know electrode-identification system

A. AC electrodes

B. DC electrodes

C. Iron powder

D. Low hydrogen

E. Stainless steel

F. Cast iron

XIV. Students will how to use shop equipment safely:

A. Band saws

B. Abrasive cut-off machine

C. Drill press

D. Grinding equipment

E. Brake

F. Shear

G. Roll fornen

H. Arbor press

XV. Students will know how to use:

A. Power tools

B. Hydraulic tools

C. Hand tools

D. Fastener
   1. Clamps
   2. Nuts and bolts

XVI. Students will be able to:

A. Plan jobs

B. Layout work

C. Estimate costs

CURRICULUM OUTLINE

I. WELDING METALLURGY

A. Definitions
1. Welding
2. Metallurgy
3. Alloy
4. Tensile strength
5. Yield strength
6. Elongation
7. Hardness
8. Thermal conductivity
9. Thermal expansion
10. Thermal contraction
11. Weldability

B. Manufacture of Steel
1. Methods
a. open hearth furnace
b. Bessemer converter
c. electric arc furnace
2. Types of steel
a. rimmed
b. capped
c. killed
d. semi-killed
e. alloys

C. Weld Cycle
1. Arc initiation
2. Base material heating
3. Weld puddle formation
4. Melting of base material
5. Solidification
6. Cool down

D. Effect of Weld Cycle
1. Base material properties
a. heat affected zone
b. unaffected base material
2. Weld nugget
3. Chemistry of deposit

E. Defects
1. Cracks
a. longitudinal
b. transverse
c. underbead
2. Porosity
3. Slag
4. Lack of fusion

F. Causes of Defects

G. Effects of Defects on Weldment Performance

H. Restraint

I. Preheat and Interpass Temperatures

J. Joint Designs

K. Distortion

L. Heat Input (Joules/Inch)

M. Selection of Welding Process

N. Stress Relieving

II. MANUAL METAL ARC (MMA) Process (THEORY)

A. Safety
   1. Personal
   2. Equipment
   3. Area

B. Manual Metal Arc Process
   1. Fusion (coalescence)
      a. electric arc
         1. circuit
         2. welding arc

C. Power Sources
   1. Alternating current (AC)
   2. Direct current (DC)
      a. DC reverse polarity
      b. DC straight polarity
   3. Types
      a. motor generator sets; alternator, electric
      b. uses
   4. Associated equipment

D. Electrodes
   1. Identification
      a. types
      b. uses
      c. polarity
      d. positions

E. Base Materials
   1. Types
      a. ferrous
      b. non-ferrous

F. Fundamentals
   1. Current settings
      a. amperage
   2. Length of arc
      a. voltage
   3. Angle of electrode
   4. Rate of travel

III. GAS METAL ARC (GMAW) PROCESS (THEORY)

A. Safety
   1. Personal
   2. Equipment
   3. Area

B. Fundamentals
   1. Current
      a. wire feed speed
      b. amperage
      c. voltage
   2. Cup-to-work distance
      a. arc length
   3. Torch or gun angle
   4. Travel rates
   5. Shield gas flow rates

C. Gas Metal Arc Welding Process
   1. Fusion (coalescence) created by metal arc
      a. circuit
      b. welding arc
   2. Metal transfers
      a. spray
      b. short circuiting

D. Power Sources
   1. Direct current (DC)
   2. Types
      a. motor generator sets
      b. rectifiers
      c. uses
   3. Associated equipment
      a. wire feed units
      b. torches and guns

E. Filler Materials
   1. Bare
   2. Cored

F. Shielding Gases
   1. Types and uses
   2. Associated equipment

G. Base Materials
   1. Types
      a. ferrous
      b. non-ferrous
      c. aluminum

H. Weldability
   1. Filler material types
   2. Procedures

IV. GAS TUNGSTEN ARC (GTAW) PROCESS (THEORY)

A. Safety
   1. Personal
   2. Equipment
   3. Area

B. Fundamentals
   1. Current (amperage)
   2. Arc length
      a. tungsten stick out
      b. cup-to-work distance
   3. Torch angle
   4. Travel rate
   5. Techniques
      a. filler wire addition
   6. Shielding gas
      a. flow rates

C. Gas Tungsten Arc Welding Process
   1. Fusion (coalescence) created by arc
      a. circuit
      b. welding arc

D. Power Source
   1. Direct current (DC)
      a. DC straight polarity
   2. Alternating current (AC)
   3. Types
      a. motor generator sets
      b. rectifiers
      c. uses
   4. Associated equipment
      a. torches
      b. tungsten (nonconsumable)

E. Filler Materials
   1. Types and uses
      a. bare

F. Shielding Gases
   1. Types and uses
   2. Associate equipment

G. Base Materials
   1. Types
      a. ferrous
      b. non-ferrous

H. Weldability
   1. Filler material types
   2. Procedures

V. OXY-FUEL WELDING AND BRAZING (THEORY)

A. Safety
   1. Personal
   2. Equipment
   3. Area

B. Fundamentals
   1. Tip size
      a. pressure
      b. flames
   2. Tip and flame distance
   3. Torch angles
   4. Rate of travel
      a. filler wire deposit
   5. Flux

C. Oxy-Acetylene Welding
   1. Fusion created by heat of flame
      a. types of flames

D. Brazing
   1. Diffusion and alloying of filler material
      a. filler - lower melting point than B/M
      b. types of flames

E. Equipment
   1. Regulators
      a. types
   2. Gases
   3. Torches
      a. types
   4. Hoses
   5. Fluxes
      a. purpose
   6. Filler
      a. welding
      b. brazing
   7. Associated

F. Base Materials
   1. Type B/M
      a. flame adjustment
      b. filler rod
      c. flux

H. Arc-Air Gouging (Theory)
   1. Safety
   2. Equipment
      a. power supply
      b. torch-hoses
      c. air supply
      d. electrodes

I. Fundamentals
   1. Set up
   2. Arc ignition
   3. Rate of travel
   4. Torch angle
   5. Arc length

J. Operations
   1. Application
      a. Prepare bevel
      b. back gouge welds
      c. Gouge all position

K. Miscellaneous Welding Processes
   1. Process considered
      a. submerged arc welding
      b. spot welding
      c. plasma welding
      d. electron beam welding
      e. flash welding
      f. stud welding
      g. electroslag welding
      h. electrogas welding

L. Discussion (Applies to Above Processes)
   1. Process description
   2. Equipment description
   3. Advantages of process
   4. Process limitations
   5. Typical applications
   6. Disadvantages of process

VI. INSPECTION AND TESTING OF WELDMENTS

A. Nondestructive Testing
   1. Visual inspection
   2. Dye penetrant
      a. spot check
      b. black light
   3. Eddy current testing
   4. Magnetic particle
      a. dry method
      b. wet method
   5. Radiographic inspection
      a. x-ray
      b. gamma
   6. Ultrasonic testing

B. Destructive Testing
   1. Tensile test
      a. compression test
   2. Free bend test
   3. Guided bend test
   4. Shearing test
   5. Nick break test
   6. Impact test
   7. Etching test
   8. Fillet weld test
      a. rupture test
   9. Hardness test
   10. Charpy test
      a. keyhold
      b. V-notch

VII. BASIC ELECTRICITY

A. Description
   1. Amperage (amperes)
   2. Voltage (volts)
   3. Resistance (ohms)
   4. Watts
   5. Relationship between amperage, voltage, resistance, watts

B. Types of Current
   1. Alternating
   2. Direct

C. Polarity
   1. Straight
   2. Reverse

D. Power supplies
   1. Input
   2. Output
   3. Duty Cycle

E. Amperage
   1. Effect on penetration
   2. Effect on melting rate (deposition)
   3. Results when using incorrect amperage
      a. arc instability
      b. lack of fusion
      c. bead contour
      d. spatter
      e. others

F. Voltage
   1. Relationship between arc voltage and arc length
   2. Effect on bead shape
   3. Results when using incorrect voltage

G. Resistance
   1. Sources for:
      a. connections
      b. size of cable
      c. length of cable
      d. contact tips (where applicable)

H. Energy Input
   1. Definition
   2. Control of
   3. Significance

VIII. BLUEPRINT READING

A. Introduction
   1. Purpose
   2. Make up of prints

B. Basic Lines
   1. Type
   2. Description
   3. Purpose

C. Basic Views

D. Notes and Specifications

E. Dimensions
   1. Purpose
      a. fraction
      b. decimal
      c. degree

F. Structural Shapes
   1. Standard gages

G. Other Views
   1. Conventional breaks
   2. Revolved sections
   3. Auxiliary views
   4. Side and partial views
   5. Enlarged detail views

H. Abbreviations Blueprint

I. Weld Symbols
   1. Basic structure
      a. reference lines
      b. arrow line
      c. elements of symbol

J. Types of Symbols
   1. Weld
   2. Finish

K. Multiple Weld Symbols

L. Dimensions of Symbols

M. Special Types of Welds

N. Abbreviations of Symbols

O. Types of Welds
   1. Basic types
      a. fillet
      b. groove
      c. plug and slot
      d. surfacing welds
      e. flange welds
      f. spot welds
      g. seam welds

IX. OXY-ACCT CUTTING

A. Safety
   1. Personal
   2. Equipment
   3. Area

B. Fundamentals
   1. Tip selection
      a. type
      b. size
   2. Pressures
   3. Tip to work distance
   4. Rate of Travel
   5. Piercing

C. Equipment
   1. Manual
      a. types
   2. Attachments
      a. circle cutting
      b. gouging
      c. specialty cutters
   3. Automatic
      a. track following
      b. pattern following
      c. pipe cutting

X. PLASMA CUTTER

A. Safety
   1. Personal
   2. Equipment
   3. Area

B. Fundamentals
   1. Current
   2. Material/thickness
   3. Gas pressures
   4. Arc Length
   5. Travel rate

C. Equipment
   1. Torch Type
      a. contact
      b. arc length
   2. Power Source
      a. types
   3. Gasses
      a. compressed air
      b. plasma-cooling gas

XI. SHOP EQUIPMENT

A. Safety
   1. Personal
   2. Equipment
   3. Area

B. Cutting Equipment
   1. Bandsaws
      a. types
      b. blade Selection
      c. blade Speed
      d. coolant
   2. Abrasive Saw
      a. types
      b. wheel selection (grit)

C. Grinding Equipment
    1. Types
    2. Grit selection

D. Other Equipment
    1. Equipment Considered
        a. brake
        b. shear
        c. roller
        d. presses
        e. punch
        f. miller
        g. lathe

E. Tools
    1. Power
        a. electric
        b. pneumatic
        c. types
        d. uses
    2. Hand
        a. types
        b. uses

F. Fasteners
    1. Clamping Devices
    2. Threaded fasteners
        a. types
        b. uses
    3. Rivel Fasteners
        a. types
        b. uses

XII. FABRICATION

A. Safety
    1. Personal
    2. Equipment
    3. Area

B. Tools
    1. Squares
    2. Levels
    3. Measuring Devices
    4. Ladders
    5. Scaffolds

C. Moving Equipment
    1. Lifting
        a. hoists
        b. chain
        c. cable

2. Jacks
   a. Types
      1) hydraulic
      2) pneumatic
      3) screw

XIII. MATHEMATICS FOR WELDERS

A. Arithmetic
   1. Whole numbers
      a. addition
      b. subtraction
      c. multiplication
      d. division
      e. measuring tools

B. Fractions
   1. Reducing of fractions
   2. Changing fractions to whole numbers
   3. Addition, subtraction, division, and multiplication

C. Percentage
   1. Decimals
   2. Finding percent
   3. Ratio and proportion
   4. Square root

D. Mensuration
   1. Areas
      a. circles
      b. triangles
      c. rectangles

E. Volumes
   1. Rectangles
   2. Cylinders
   3. Triangles
   4. Cylinders

F. Cost and Estimating
   1. Design for economical use of filler metal
      a. accessibility
      b. filler metal deposited -
         types weld joints

G. Plan for Conservation of Material
   1. Poor fit-up
   2. Overwelding

H. Selling-Up Fixtures

I. Positioning Fixtures

J. Economical Size and Type Filler Material
   1. Stubb loss
   2. Cost in pounds deposited
      a. process

K. Operator Factor

L. Quality Welds to Minimize Rewelding

M. Welding Process
   1. Cost comparison per process
      a. operator factor
      b. weld deposited

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RECORDING STUDENT PROGRESS

A major principle of vocational education is that the students learn skills of the performance of operations of a trade with the production job vehicle to accomplish this objective.

The operations are defined on the shop progress record and it is imperative that the instructor have some means of recording the student's experiences and achievement.

The method of recording student progress is as follows:

INSTRUCTED - This designation on the progress record indicates that the student has performed a skill with the assistance of and under the supervision of the instructor.

PRACTICED - This designation on the progress record indicates that the student has performed a skill either by himself/-herself or with little help from the instructor.

PROFICIENT - This designation on the progress record indicates that the student is capable of performing a skill by himself/herself within a reasonable amount of time with no assistance from the instructor. In effect this implies that the student has been tested for that skill.

This method of noting student progress will define accurately student achievement and, in fact, will point out any weaknesses the student may have in certain operations; thus highlighting areas where the student may need help.

Grades should be kept on student daily progress cards or in roll books.

Grade_____ Year_____ Instructor_____

STUDENT	TOOL CHECK NO.	LOCKER NO.	TEXT BOOK NO.	SHOP GRADES MARKING PERIOD						THEORY GRADES MARKING PERIOD					
				1	2	3	4		F	1	2	3	4		F

Grade_____ Year_____ Instructor_____

TOOL CHECK NO.	LOCKER NO.	TEXT BOOK NO.	SHOP GRADES MARKING PERIOD						THEORY GRADES MARKING PERIOD					
			1	2	3	4		F	1	2	3	4		F

Grade_____ Year_____ Instructor_____

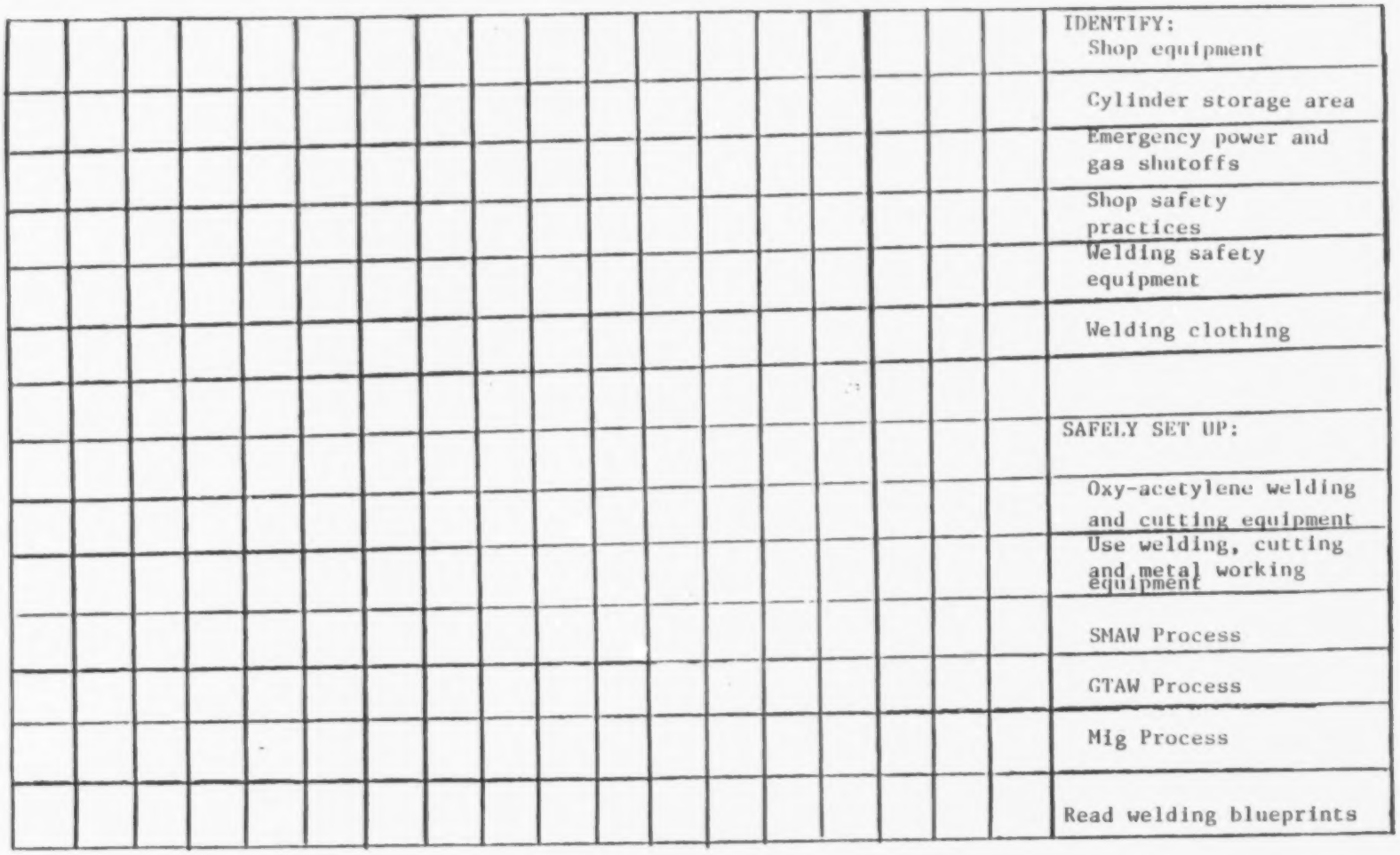
TOOL CHECK NO.	LOCKER NO.	TEXT BOOK NO.	SHOP GRADES MARKING PERIOD						THEORY GRADES MARKING PERIOD					
			1	2	3	4		F	1	2	3	4		F

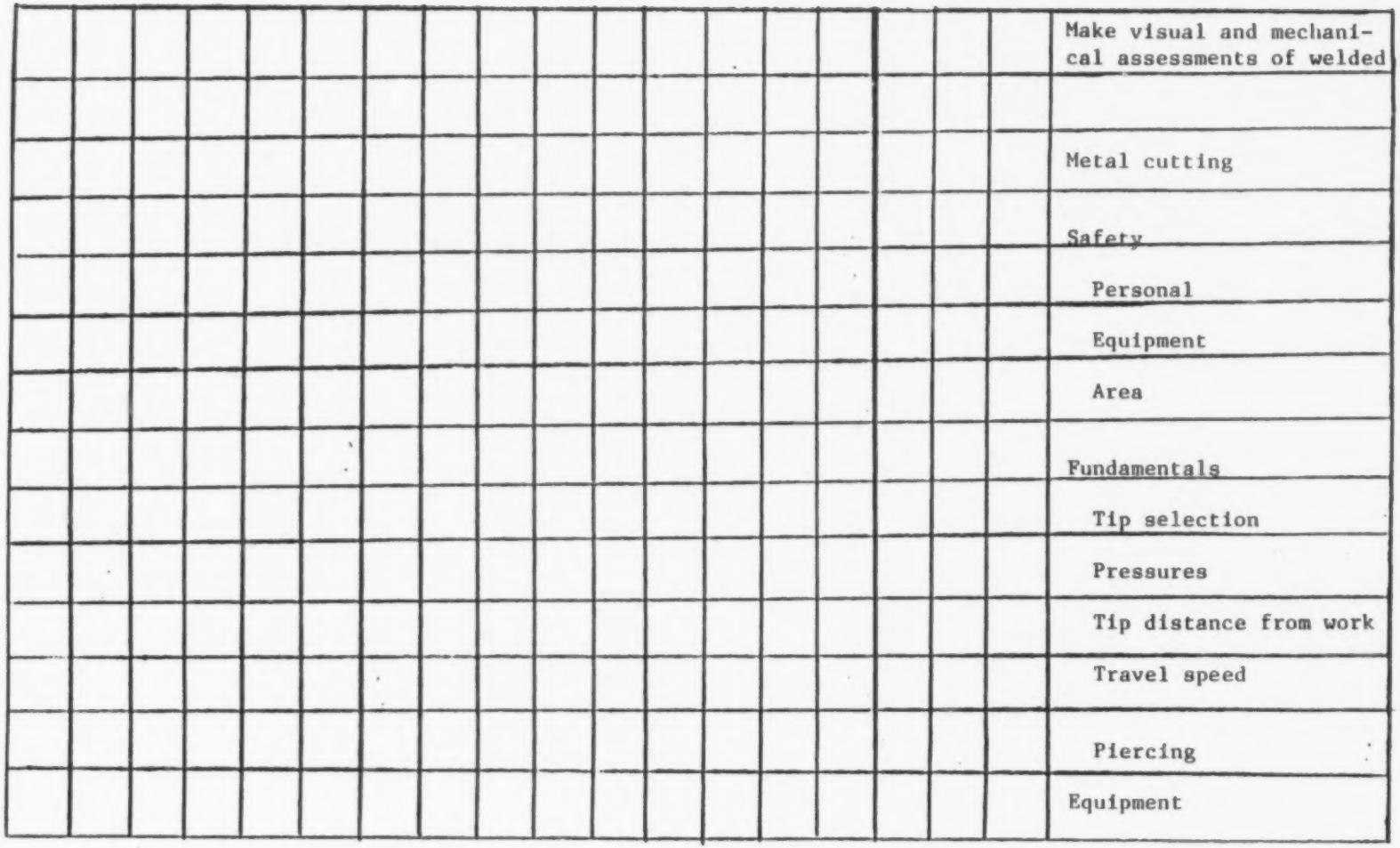
Grade_____ Year_____ Instructor_____

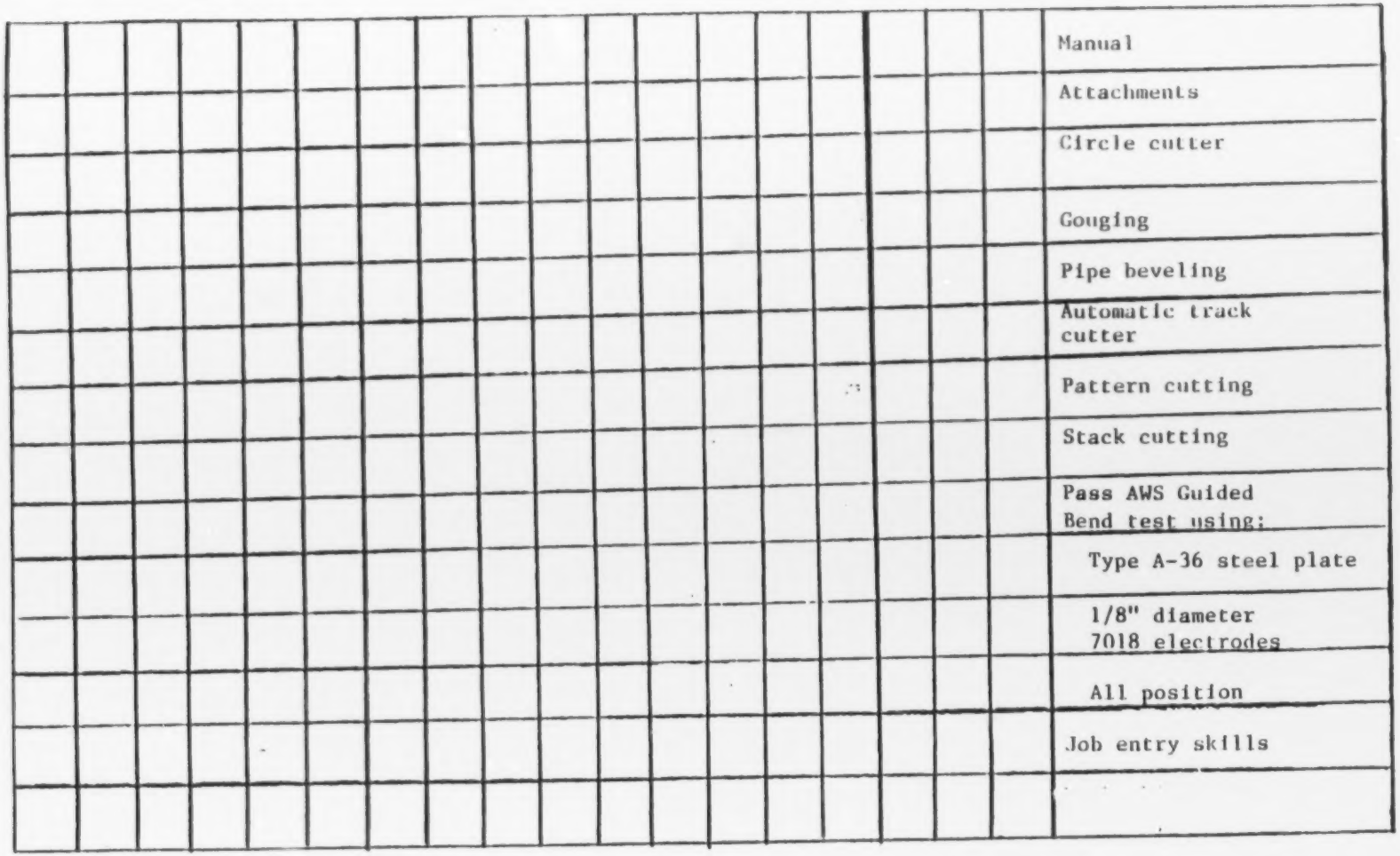
TOOL CHECK NO.	LOCKER NO.	TEXT BOOK NO.	SHOP GRADES MARKING PERIOD						THEORY GRADES MARKING PERIOD					
			1	2	3	4		F	1	2	3	4		F

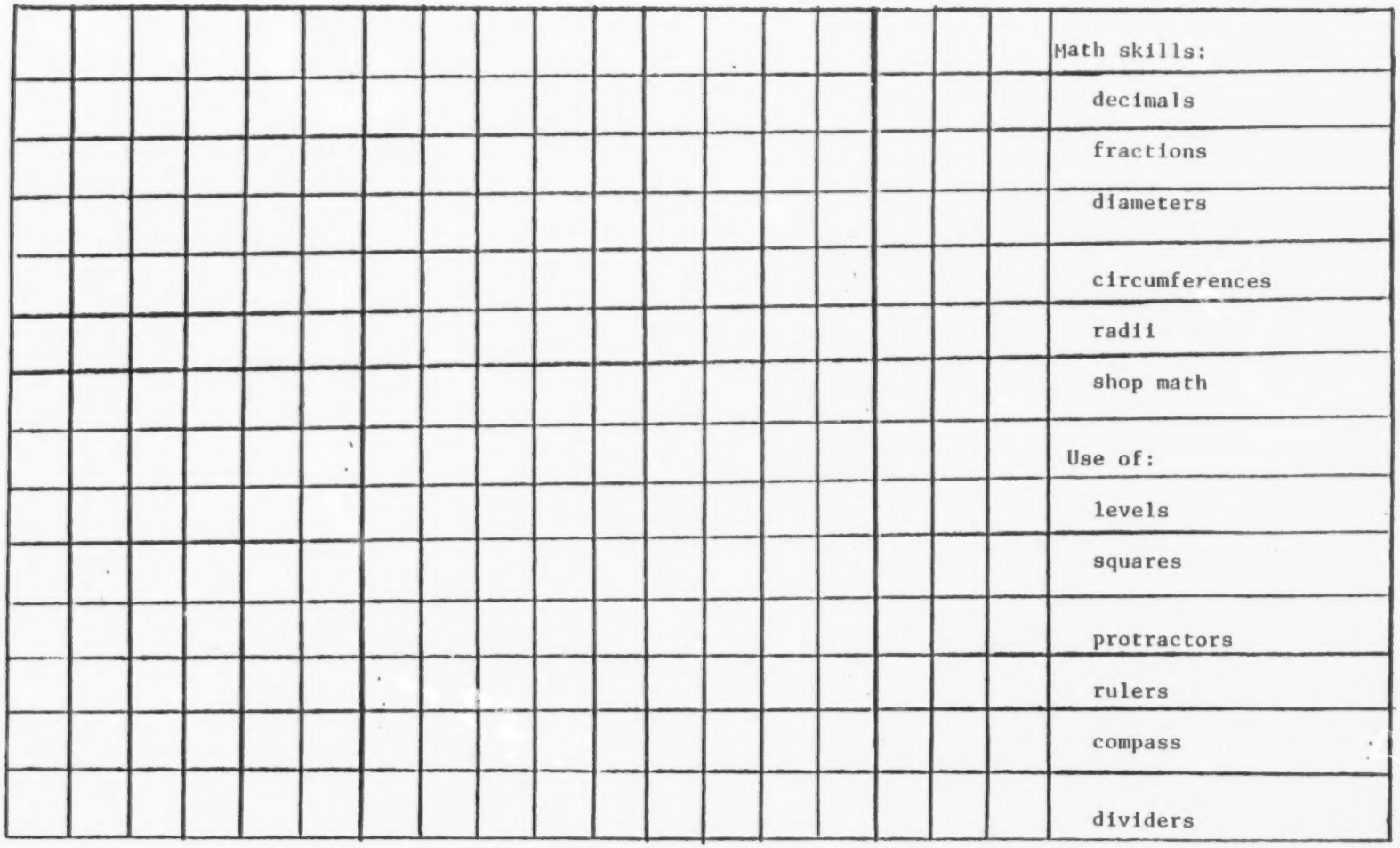
Grade _____ Year _____ Instructor _____

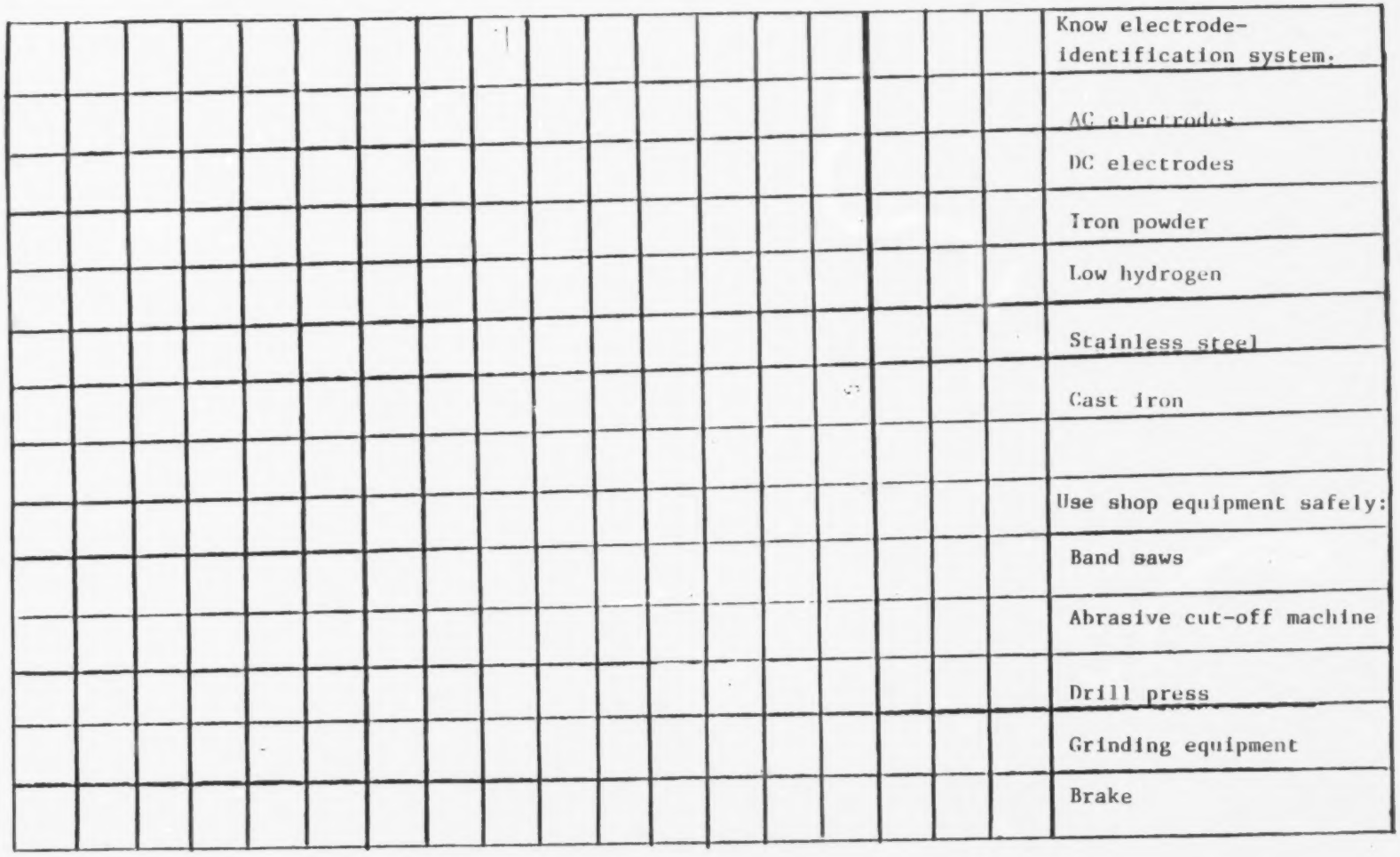
TOOL CHECK NO.	LOCKER NO.	TEXT BOOK NO.	SHOP GRADES MARKING PERIOD						THEORY GRADES MARKING PERIOD					
			1	2	3	4		F	1	2	3	4		F

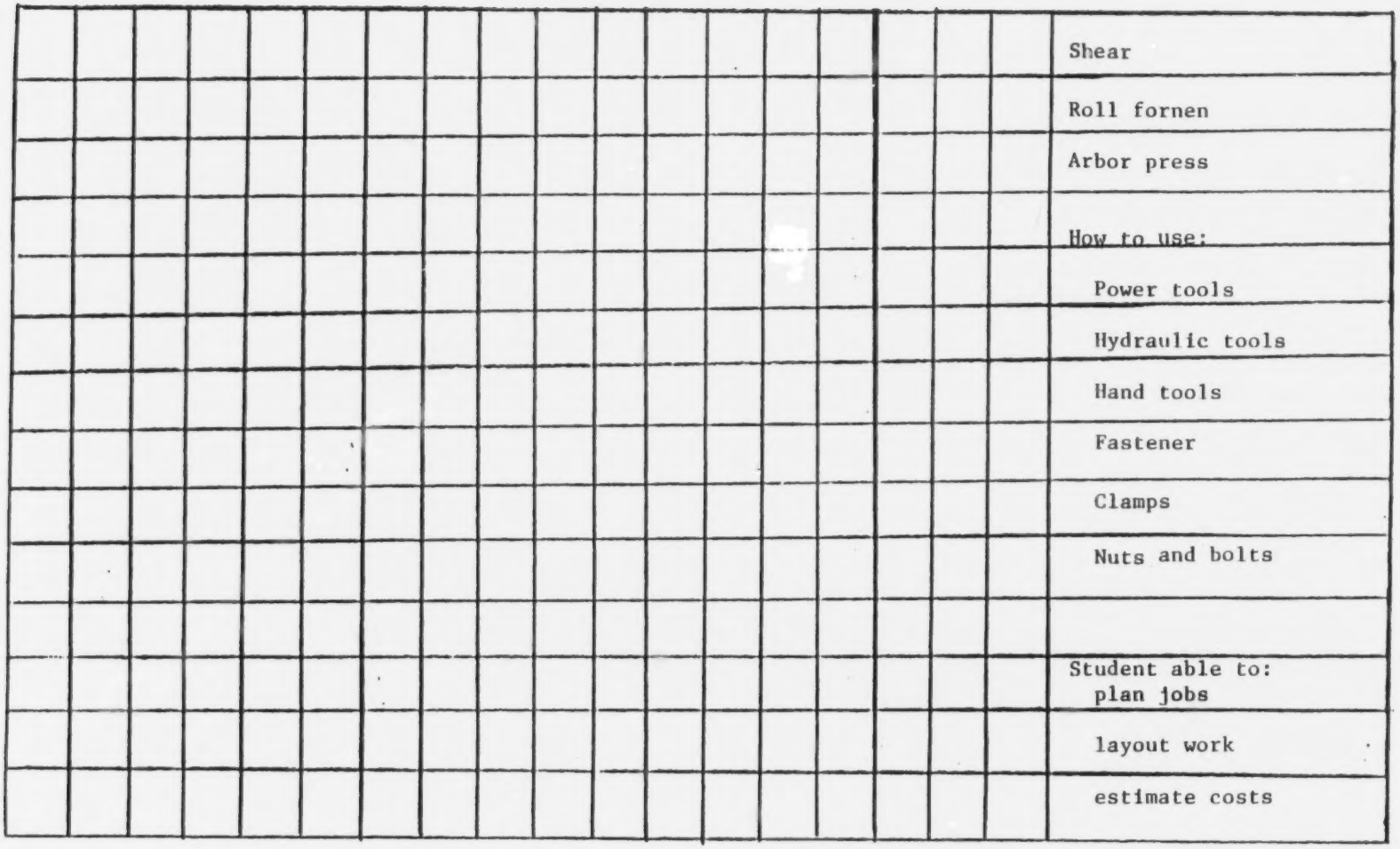

IDENTIFY:
Shop equipment
Cylinder storage area
Emergency power and gas shutoffs
Shop safety practices
Welding safety equipment
Welding clothing
SAFELY SET UP:
Oxy-acetylene welding and cutting equipment
Use welding, cutting and metal working equipment
SMAW Process
GTAW Process
Mig Process
Read welding blueprints


Make visual and mechanical assessments of welded parts
Metal cutting
Safety
Personal
Equipment
Area
Fundamentals
Tip selection
Pressures
Tip distance from work
Travel speed
Piercing
Equipment


Manual
Attachments
Circle cutter
Gouging
Pipe beveling
Automatic track cutter
Pattern cutting
Stack cutting
Pass AWS Guided Bend test using:
Type A-36 steel plate
1/8" diameter 7018 electrodes
All position
Job entry skills


Math skills:
decimals
fractions
diameters
circumferences
radii
shop math
Use of:
levels
squares
protractors
rulers
compass
dividers


Know electrode-identification system.
AC electrodes
DC electrodes
Iron powder
Low hydrogen
Stainless steel
Cast iron
Use shop equipment safely:
Band saws
Abrasive cut-off machine
Drill press
Grinding equipment
Brake


Shear
Roll fornen
Arbor press
How to use:
Power tools
Hydraulic tools
Hand tools
Fastener
Clamps
Nuts and bolts
Student able to:
plan jobs
layout work
estimate costs